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Research and Exploration into the Development of Students' Practical and Innovative Abilities in Engineering Colleges

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Abstract

Practical teaching plays an important role in developing students' practical and innovative abilities. Starting from the idea of "emphasis on practice and ability", this article proposes to take a series of measures to improve students' practical ability in undergraduate teaching. In addition, a platform should be built to develop students' innovative abilities. Our practice has shown that these measures have taken favorable effects.

Keywords: Practical teaching, Practical ability, Innovative ability, Teaching reform

Due to the great significance of practice in college students' development, colleges have been putting much importance on improving students' practical and innovative abilities. Based on its guideline of "solidifying foundation, emphasizing ability, paying attention to innovation and achieving all-round development" as well as its objective to develop students "with strong practical, innovative and development abilities", North China Electric Power University have taken great efforts to conduct research on experimental and practical teaching system, promote its reform in talent cultivation pattern, optimize its experimental and practical teaching system, establish its practice bases, hence promoting the development of students' practical and innovative abilities to a large extent.

1. Optimizing Talent Cultivation Scheme and Establishing Experimental and Practical Teaching System with Four Modules and Three Layers

It is particularly important for engineering colleges to establish perfect experimental and practical teaching system to equip their students with necessary practical abilities. Our school has conducted research on such a system according to the basic rule of "basic experiment--engineering practice on and off campus-- comprehensive professional practice", enhanced the construction of such a system with four modules, characterized by simulation, relying on practice bases and supported by open management. In this system, the four modules include basic experimental teaching, on-campus practical teaching, simulation practical teaching and off-campus practical teaching. To be specific, the average periods of experimental and practical teaching take up over 33% of the total. In addition, a lot of optional practice has been offered to students to give them sufficient training in experiment and practice. In the recent years, our school has conducted practical teaching reform to develop students' practical and innovative abilities.

1.1. Reforming Verification Experiment and Emphasizing Design Experiment

In the basic experimental teaching module, great efforts have been made to reduce verification experiments and increase design and comprehensive ones: (1) eliminating those old-fashioned facilities and adding those facilities related to new contents and methods, such as EDA lab, mathematics lab, electromagnetic measurement simulation lab and so on. (2) encouraging teachers to develop their own experimental facilities, especially those design and comprehensive ones, such as auto-control experimental teaching system, computer-line auto-protection experimental system and so on. Up to now, over 320 sets of facilities developed by teachers themselves have produced favorable economic and social benefits as well as fulfilling our own demands for experiment. (3) integrating experimental resources and constructing comprehensive experimental teaching center, such as the construction of electrical engineering and electronics experimental teaching center by combing the former electrical engineering lab, electronic lab and a variety of measurement labs in different colleges and departments. This center has done a lot in exerting the advantages of professors-in-charge in teaching and research and coordinating strong and weak points, hardware and software, theory and practice. In addition to basic experiments in electrical engineering and electronics, a series of comprehensive and design experiments have been conducted, such as comprehensive design of electronic system, comprehensive electromagnetic measurement, sensor measurement and control and so on. By integrating teaching resources, the utility of resources as well as the construction of labs and practical teaching have been improved.

1.2. Reforming Monotonous Skill Training and Emphasizing Systematic Engineering Practice

In our on-campus engineering practice, the former monotonous skill training has given way to some comprehensive and systematic practical projects related to research and development, such as the design, manufacturing, installation and testing of mechanic devices in the engineering training center; the series design projects of low-voltage set switchgear equipment in the electrical engineering practice base; the installation, debugging, operation of heating system, the design of air-conditioning system and the design and manufacturing of gas top and so on. By taking part in these practical activities including basic practice, project design, project budget, engineering production, engineering experiment, failure elimination and so on, students have got all-round practical training.

1.3. Introducing Simulation Technology into Practical Teaching and Emphasizing Advanced Practical Methods

As a technology-and-capital-intensive industry, electric power, with continuous and safe manufacturing process, requires technicians to remove possible breakdowns. Based on this feature, our university have introduced modern simulation technology into practical teaching and established "practical teaching simulation module" in those main majors. Up to now, we have established a simulation system of electric power production and transportation including the largest thermal power installation simulation, nuclear power installation simulation, electric power system simulation, power grid scheduling simulation in China and we have been qualified to award relevant certificates. This system is equipped with systematic virtual reality environment similar to real production, in which students are able to set system failures and learn how to eliminate them. Students trained in this practice will adapt themselves to their new jobs soon, hence popular with employing units.

In addition, our university has developed other series of simulation systems in experimental teaching, such as electric dust remover simulation system, smoke desulfurization simulation system, dynamic virtual system of electric power, simulation device of computer-line protection and so on. It has become a distinguishing feature in the practical teaching of North China Electric Power University to introduce simulation practical teaching into the teaching process as an independent module.

1.4 Improving the Cooperation between University and Enterprise and Emphasizing Interactive Enterprise Local Practical Teaching

In order to change the former situation in which enterprises accepted trainees passively, cooperative and mutual beneficial system should be established between university and enterprise. In our university, the board of directors has been taken advantage of to establish such favorable relationship with enterprises in talent cultivation, technological service, staff training and other aspects and declare it in the form of agreements. In addition, over 100 off-campus practice bases have been established in the surrounding areas. It has been our usual practice to organize and arrange off-campus practice in teaching schedule and to hold regular meetings with those teachers in charge of practice bases to coordinate practice contents and timetable. At any practice base, students are made to be responsible for certain posts and are managed by both the university and the base.

2. Constructing On-campus Practice Base and Providing Students with Favorable Places for Practical and Innovative Activities

Favorable places play an important part in the cultivation of students' practical and innovative abilities. Based on the former labs, our university has constructed a series of open practice bases according to different characteristics of different grades, providing good environment and platform for students to conduct innovative and practical activities.

2.1 Establishing Basic Course Innovative Practice Bases

With mathematics and physics as compulsory basic courses for all engineering students, our university has established some relevant innovative practice bases to encourage students to take part in innovative practice from the very beginning. In the physics innovative practice base are established a research hall of physical phenomena and a design and making room. There are some famous demonstrative experiments and students' science and technology works on display in the former and some tools used for mechanic processing and circuit welding in the latter. In the teaching process, teachers will begin with guiding students to observe physical phenomena and lead them to develop some instruments for physical teaching and some minor inventions and further to conduct technological innovations and grasp scientific research methods. At the mathematics innovative practice base, students have developed a variety of calculation software related to advanced mathematics, engineering mathematics, modern mathematics and a mathematics experiment system based on campus web. In this way, online calculation and visual output of mathematical curve can be achieved. Up to now, it has become an important place for students' mathematics modeling activities and has helped students to achieve prizes in some international and national competitions.

2.2 Constructing On-campus Practice Bases

In order to overcome some difficulties and shortcomings in off-campus practice and achieve better effect in practice, our school has done a lot in constructing a series of practical training bases.

(1) strengthening the construction of engineering training center. In order to train students in metalworking practice in a better way, our school has introduced numerical-control processing center, graphic studio, industrial robots, comprehensive electrical engineering and electronics experimental system and some other facilities to form a modern engineering technology training center integrating some comprehensive technologies such as computer, mechanics, electronics, electric appliance transmission and control. There students are able to conduct their comprehensive innovative practice such as computer-aided design and manufacturing, typical industrial mechanical and electrical equipment monitor and control as well as some basic skill training in metalworking, electrical engineering and electronics.

(2) constructing simulation practice bases. An on-campus practice base for building environment has been established, including simulation heating system with mechanically recirculating hot water, simulation experimental system of air-conditioning, simulation experimental system of large-scale central air-conditioner, to provide students with an experimental and practical place quite similar to different working conditions. After learning about the factual conditions in real working places, students will conduct their data collection, analysis and study at these practice bases. Better effects have been achieved in this way.

(3) making full use of multi-media technology to construct virtual production sites. We have constructed a virtual power generation scene to help students to have a complete understanding of a power plant and give them a chance to observe some critical operations such as overhaul, start and stop of power generation facilities. First, we have produced some models for critical parts as well as used some old parts discarded by power plants to give a detailed introduction of the structure and operation process of power generation facilities. Second, we have recorded the processes of installation, start and stop of some critical systems in the audio and video forms and publicize them on our campus web to give students an access to the production, the structure of critical facilities and critical technological processes in a real power plant, hence helping a lot in improving the effect of our practical activities.

2.3 Establishing On-campus Engineering-type Practice Bases

Our school has established an on-campus electrical engineering practice base with some donated as well as purchased facilities. With 37 sets of facilities including motor, transformer, circuit breaker, electric power distribution cabinet and so on, students will be able to design and practice 36 plans including mechanical and electrical drive and control, large-scale disposable facilities of electric power system and to conduct design experiments in over 40 series such as low-voltage set switchgear facilities. All these programs are optional for students in different majors and at different levels. With these facilities, students will not only learn and use relevant national and industrial standards to design and draw shop drawing but also learn to operate some typical facilities and eliminate some failures in them and design and make low-voltage transformation and distribution facilities.

2.4 Establishing Research-type Innovative Practice Bases

In order to develop and improve senior students' research abilities, our school has established a simulation and control innovative practice base, an EDA innovative practice base based on the former key lab of industrial control and simulation at the ministerial level and EDA lab. Three research categories have been planned according to the characteristics of undergraduates and some existing research projects in our labs. The first category is equivalent to graduation project, such as the development of module neural network model based on simulation platform and the analysis and research on unit plant load control system at the simulation base, and the design of self-adapting filter and the EFGA of interleave and deinterleave in telecommunication system; the second is equivalent to course design, such as the analysis and research on single circuit feedback control system and so on; the third includes other minor projects, such as the start-stop control of pulverizers and so on. Some excellent projects are chosen to be made use of in the development of new facilities in our laboratory work.

3. Deepening Management System Reform and Establishing Open Operation System

In order to provide undergraduates with favorable environment and conditions for innovative and practical activities, our school has taken measures to establish open operation system of labs (bases).

3.1 Establishing Professor-in-charge Post to Attract Excellent Teachers to Laboratory Work

To encourage and attract excellent teachers to construct and manage labs, our school has set the professor-in-charge post in key labs at different levels, laboratory teaching center and engineering training center. Allowance will be given to those professors-in-charge with high academic achievements, rich experience in teaching and research and strong sense of responsibility. Now the first batch of professors-in-charge have been allocated to different labs including the electric power intelligent protection and control lab, the electromagnetic field analysis and testing and electromagnetic compatibility lab, the simulation control center, the electrical engineering and electronic experiment teaching center and the engineering training center. The above measures have improved our experimental team construction and our practical teaching.

3.2 Establishing Extracurricular Optional Practical Projects to Enrich Open Lab Contents

The key in opening the lab lies in having enough research and practical projects for students to conduct their practical

activities and therefore to improve their relevant abilities. We have done some beneficial attempts in this aspect, requiring all labs and practice bases to open themselves by repeating some experiments conforming to the teaching plan, or disintegrating teachers' research projects into some specific experimental subjects or working out some comprehensive and design experiments. In addition, we have laid down the project credit assessment standard in which certain credits are given according to the difficulty and content in different lab tasks and have publicized some information such as the brief introduction, reference, requirements of applicants, credit on the campus web. Besides, students can work out their own projects of scientific and technological activities and conduct their practical activities by booking in advance.

3.3 Establishing Special Opening Fund to Improve Teachers' Enthusiasm in Opening Labs

Now, special opening fund has been set aside to encourage lab staff and instructors to take part in the opening work of labs. Besides for materials, this fund is also used to pay teachers for their extra work in instructing students' experiments. At the beginning of each term, open labs are expected to submit their plans for open experiment projects and budget. At the end of each term, a result report should be submitted, which includes students' attendance and report cards, instructors' workload and so on. This fund has given necessary financial support to labs for their opening work, encouraging teachers' enthusiasm effectively.

3.4 Setting Extracurricular Ability and Quality Credit to Encourage Students' Enthusiasm for Extracurricular Practice

Students being the center of opening labs, only by encouraging students as well as teachers' enthusiasm can we establish a constant lab opening system. Therefore, our school has set extracurricular ability and quality credit system, according to which certain credit will be recorded into students' documents if they have finished a practice project as required. This credit will take a part in annual competition for prizes and awards, sometimes replace that of some optional courses or even replace course design or graduation project if a project has been approved in oral defense. In addition, according to our new regulation of recommending students to be postgraduates without national exam, students' innovative abilities are emphasized. Accordingly, their grades in extracurricular practical and innovative activities are regarded one of the important requirements during the course.

Due to our optimized practical teaching system, favorable practical teaching conditions, open management and support system, students' enthusiasm for practice and their practical and innovative abilities have been improved. Therefore, with our graduates quite popular with employing units with their solid foundation, strong ability, originality and devotion, our employment rate has been remaining above 98%. In the recent years, more than 80% students have taken part in all kinds of sci-tech and cultural activities every year and have achieved great achievements. And due to our multi-channel, multi-form and large-scale innovative activities for students, our school has been given the title of "Youth Sci-Tech Innovative Education Base"

Reference

An, Liansuo. (2005). *Innovation and Practice of Student-based Talent Cultivation Pattern.* China University Teaching. (6).

An, Liansuo. (2006). *Optimizing System, Creating atmosphere and Improving Students' Practical Abilities.* China University Teaching. (5).

Han, Qingqing. Zhong, Mingwen. (2007). *Exploration into Innovative Undergraduate Cultivation Pattern.* High Engineering Education Research. (3).

Han, Zhiyuan. Mao, Yiping. (2004). *Exploration in Research Training Plans for Undergraduates in a Research-oriented University*. Higher Education. (2).

Hong, Tao. (2003). *Exploration into Basic Quality and Cultivation of Innovative Talents.* Higher Education Forum. (5).

Shang, Yong. (2005). *Putting Much Importance on Innovative Talent Cultivation*. Science and Technology Journal. (10).

Wang, Xiumei. (2006). *Reflections on Relying on School Board to Promote Electric Power Talent Cultivation*. China Electric Power Education. (1).

Wang, Xiumei. (2006). *Research on Higher Engineering Education and Engineering and Technology Talent Cultivation*. Journal of North China Electric Power University (social science). (3).

Wang, Xiumei. (2006). *Constructing Distinctive Specialized Education Based on Social Demands.* Report of Strategic Research Key Project. 66-67.

Zheng, Nanning. (2006). *On the Cultivation of Innovative Talents in Engineering Education.* Higher Engineering Education Research. (2).

(2007). Brief of Facing 21st Century Innovative Engineering Gifts Cultivation Forum, Higher Engineering Education Research. (4).